

What is claimed is:

1           1.    A method for adaptive reduction of ringing artifacts  
2    in an input image including pixels of image information,  
3    comprising the steps of:

4                   (a)   selecting a pixel window including a set of  
5    pixels from the input image pixels;

6                   (b)   detecting areas of ringing artifacts in the  
7    pixel window based on the pixel information;

8                   (c)   processing the pixels in the detected areas to  
9    reduce the detected ringing artifacts in those areas; and

10                  (d)   generating an enhanced output image including  
11   the processed pixels with reduced ringing artifacts.

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1           2.    The method of claim 1, wherein in step (b) detecting  
2   the areas of ringing artifacts includes the steps of:

3                   detecting areas of ringing artifacts in the pixel  
4   window as a function of gradation level differences between  
5   one or more pixels therein.

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1           3.    The method of claim 1, wherein in step (b) detecting  
2   the areas of ringing artifacts includes the steps of:

3           for a pixel in the window, determining the gradation  
4   level difference between that pixel and that of neighboring  
5   pixels; and

6           detecting if the gradation level difference is  
7   within a selected threshold, indicating ringing-like artifacts  
8   proximate the pixel position in the window.

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1       4.    The method of claim 1, wherein in step (c)  
2   processing said pixels includes the steps of performing low  
3   pass filtering of the pixels to reduce the ringing artifacts.

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1       5.    The method of claim 1, wherein in step (c)  
2   processing said pixels includes the steps of performing  
3   smoothing on the pixels to reduce the ringing artifacts.

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1       6.    The method of claim 1, wherein in step (d)  
2   generating an enhanced output image further includes the steps  
3   of:

4           generating an enhanced output image comprising: (i)  
5   the processed window pixels with reduced ringing artifacts,  
6   and (ii) the remaining window pixels.

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1       7.    The method of claim 1 wherein the input image  
2   comprises a decompressed image.

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1        8.    A method for adaptive reduction of ringing artifacts  
2    in an input image including pixels of image information,  
3    comprising the steps of:

4            (a)   selecting a pixel window including a set of  
5    pixels from the input image pixels;

6            (b)   detecting areas of ringing artifacts in the  
7    pixel window based on the pixel information;

8            (c)   processing the pixels in the window to generate  
9    processed pixels including pixels with reduced ringing  
10   artifacts;

11           (d)   selecting pixels with reduced ringing artifacts  
12   from the processed pixels, based on the detected ringing  
13   artifact areas; and

14           (e)   generating an enhanced output image comprising:  
15   (i) the selected pixels, and (ii) the remaining window pixels.

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1        9.    The method of claim 8, wherein in step (b) detecting  
2    the areas of ringing artifacts includes the steps of:

3            detecting areas of ringing artifacts in the pixel  
4    window as a function of gradation level differences between  
5    one or more pixels therein.

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1           10. The method of claim 8, wherein in step (b) detecting  
2 the areas of ringing artifacts includes the steps of:

3                 for a pixel in the window, determining the gradation  
4 level difference between that pixel and that of neighboring  
5 pixels; and

6                 detecting if the gradation level difference is  
7 within a selected threshold, indicating ringing-like artifacts  
8 proximate the pixel position in the window.

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1           11. The method of claim 8, wherein in step (c)  
2 processing said pixels includes the steps of performing low  
3 pass filtering of the pixels to reduce ringing artifacts.

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1           12. The method of claim 8, wherein in step (c)  
2 processing said pixels includes the steps of performing  
3 smoothing on the pixels to reduce ringing artifacts.

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1           13. The method of claim 8 wherein the input image  
2 comprises a decompressed image.

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1           14. A method for adaptive reduction of ringing artifacts  
2 in an input image including pixels of image information,  
3 comprising the steps of:

4                   (a) selecting a pixel window including a set of  
5 pixels from the input image pixels;  
6                   (b) detecting areas of ringing artifacts in the  
7 pixel window based on the pixel information;  
8                   (c) determining local variance of each pixel in the  
9 window with respect to neighboring pixels;  
10                   (d) based on the local variances, detecting if the  
11 location of the window is proximate a noisy area in the input  
12 image;  
13                   (e) processing the window pixels to generate  
14 processed pixels including pixels with reduced ringing  
15 artifacts;  
16                   (f) selecting pixels with reduced ringing artifacts  
17 from the processed pixels, based on the detected ringing  
18 artifact areas and the detected window location information;  
19 and  
20                   (g) generating an enhanced output image comprising:  
21 (i) the selected pixels, and (ii) the remaining window pixels.

22  
1           15. The method of claim 14, wherein in step (b)  
2 detecting the areas of ringing artifacts includes the steps  
3 of:

4           detecting areas of ringing artifacts in the pixel  
5 window as a function of gradation level differences between  
6 one or more pixels therein.

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1           16. The method of claim 14, wherein in step (b)  
2 detecting the areas of ringing artifacts includes the steps  
3 of:

4           for a pixel in the window, determining the gradation  
5 level difference between that pixel and that of neighboring  
6 pixels; and

7           detecting if the gradation level difference is  
8 within a selected threshold, indicating ringing-like artifacts  
9 proximate the pixel position in the window.

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1           17. The method of claim 14, wherein in step (e)  
2 processing said pixels includes the steps of performing low  
3 pass filtering of the pixels to reduce ringing artifacts.

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1           18. The method of claim 14, wherein in step (e)  
2 processing said pixels includes the steps of performing  
3 smoothing on the pixels to reduce ringing artifacts.

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1           19. The method of claim 14 wherein the input image  
2 comprises a decompressed image.

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1        20. The method of claim 14, wherein in step (f)  
2        selecting pixels with reduced ringing artifacts from the  
3        processed pixels, further includes the steps of:

4                (f) selecting pixels with reduced ringing artifacts  
5        from the processed pixels in the detected ringing artifact  
6        areas, based on the window location information.

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1        21. The method of claim 14, wherein in step (f)  
2        selecting pixels with reduced ringing artifacts from the  
3        processed pixels, further includes the steps of:

4                (f) selecting pixels with reduced ringing artifacts  
5        from the processed pixels in the detected ringing artifact  
6        areas, substantially in noisy picture locations.

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1        22. A device that adaptively reduces ringing artifacts  
2        in an input image including pixels of image information,  
3        comprising:

4                a ringing-artifact detector that detects areas of  
5        ringing artifacts in a pixel window based on the pixel  
6        information, the pixel window including a set of pixels from  
7        the input image pixels;

8                an image processor that processes window pixels to  
9        generate pixels with reduced ringing artifacts; and

10           a combiner that selects the processed pixels with  
11 reduced ringing artifacts in the detected ringing-artifact  
12 areas, and generates an output image comprising: (i) the  
13 selected processed pixels with reduced ringing artifacts, and  
14 (ii) the remaining window pixels.

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1       23. The device of claim 22, wherein the ringing-artifact  
2 detector detects the areas of ringing in the pixel window as a  
3 function of gradation level differences between one or more  
4 pixels therein.

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1       24. The device of claim 22, wherein the ringing-artifact  
2 detector determines the gradation level difference between a  
3 pixel and that of neighboring pixels, and detects if the  
4 gradation level difference is within a selected threshold,  
5 indicating ringing-like artifacts proximate that pixel  
6 position in the window.

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1       25. The device of claim 22, wherein the image processor  
2 includes a low pass filter that reduces ringing artifacts.

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1       26. The device of claim 22, wherein the image processor  
2 includes a smoother that reduce ringing artifacts.

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1           27. The device of claim 22, further comprising:  
 2                 a variance detector that determines local variance  
 3 of each pixel in the window with respect to neighboring  
 4 pixels;  
 5                 a signal detector that based on the local variances,  
 6 detects if the location of the window is proximate a noisy  
 7 area in the input image;  
 8                 such that the combiner further selects pixels with  
 9 reduced ringing artifacts from the processed pixels, based on  
 10 the detected ringing artifact areas and the detected window  
 11 location information, and generates that enhanced output image  
 12 comprising: (i) the selected pixels, and (ii) the remaining  
 13 window pixels.

14  
 1           28. The device of claim 27, wherein the combiner pixels  
 2 with reduced ringing artifacts from the processed pixels in  
 3 the detected ringing artifact areas, based on the window  
 4 location information.

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 1           29. The device of claim 28, wherein the combiner selects  
 2 pixels with reduced ringing artifacts from the processed  
 3 pixels in the detected ringing artifact areas, substantially  
 4 in noisy picture locations.

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- 1           30. The device of claim 22 wherein the input image
- 2 comprises a decompressed image.